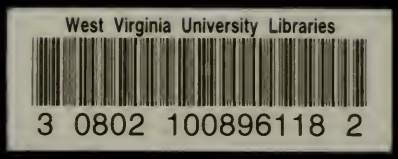

West Virginia University Libraries
3 0802 100896118 2

Digitized by the Internet Archive
in 2010 with funding from
Lyrasis Members and Sloan Foundation

http://www.archive.org/details/westvirginiapast177cook

Bulletin 177 August, 1922

Agricultural Experiment Station

College of Agriculture, West Virginia University

HENRY [illegible]HT, Director

[illegible]town

West Virginia Pastures

A Typical Bluegrass Pasture in a Limestone Section of the State.

BY

I. S. COOK

Bulletins and Reports of this Station will be mailed free to any citizen of West Virginia upon written application. Address Director of the West Virginia Agricultural Experiment Station, Morgantown, W. Va.

Agricultural

College of Agriculture ... Virginia University
FRANK B. T... TER, President

THE STATE BOARD OF CONTROL

JAMES S. LAKIN, President.....Charleston, W. Va.
J. WALTER BARNES, Treasurer.....Charleston, W. Va.
JOHN S. DARST.....Charleston, W. Va.

The State Board of Control has the direction of the financial and business affairs of the state educational institutions.

THE STATE BOARD OF EDUCATION

GEORGE M. FORD, State Superintendent of Schools, President.....Charleston, W. Va.
BERNARD McCLAUGHERTY.....Bluefield W. VA.
HOWARD M. GORE.....Clarksburg, W. Va.
EARL W. OGLEBAY.....Wheeling, W. Va.
L. W. BURNS.....Grafton, W. Va.
W. C. COOK.....Welch, W. Va.
MRS. LENNA LOWE YOST.....Morgantown, W. Va.

The State Board of Education has charge of all matters of a purely scholastic nature concerning the state educational institutions.

Agricultural Experiment Station Staff

HENRY G. KNIGHT, Ph.D.....Director and Research Chemist
CHARLES EDWARD WEAKLEY, Jr.....Assistant Chemist
WILLIAM EARL RUMSEY, B.S. Agr.....State Entomologist
LEONARD MARION PEAIRS, M.S.....Research Entomologist
NAHUM JAMES GIDDINGS, Ph.D.....Plant Pathologist
ANTHONY BERG, B. S.....Assistant Plant Pathologist
EVERETT CHARLES SHERWOOD, M.S.....Assistant Plant Pathologist
ERNEST LEE ANTHONY, M.S.....Dairyman
HARRY ORAN HENDERSON, M.S.....Assistant Dairyman
HORACE ATWOOD, M.S. Agr.....Poultry Research
EUGENE PEYTON DEATRICK, Ph.D.....Research in Soils
HAROLD JAMES BARRETT, M.S.....Assistant in Soils
*THEODORE CLINTON McILVAINE, M.S. Agr.....Assistant in Soils
RALPH JOHN GARBER, Ph.D.....Associate in Agronomy
KARL SPANGLER QUISENBERRY, B.S.....Assistant in Agronomy
THEODORE EUGENE ODLAND, M.S.....Assistant in Agronomy
MAXWELL JAY DORSEY, Ph.D.....Horticulturist
LUTHER FRANCIS SUTTON, B.S., B.S. Agr.....Assistant Horticulturist
HARRY EDWARD KNOWLTON, Ph.D.....Assistant Horticulturist
HARLEY LUCIUS CRANE, M.S. Agr.....Assistant Rorticulturist
KYLE CHESTER WESTOVER, B.S.....Assistant Horticulturist
ERNEST ANGELO, B.S. Agr.....Assistant Horticulturist
ROBERT ROSEBERRY JAMISON, B.S. Agr.....Assistant Horticulturist
EDWARD ALEXANDER LIVESAY, M.S. Agr.....Animal Husbandman
JOHN HARWOOD LONGWELL, A.M.....Assistant in Animal Husbandry
*ROSS HOMAN TUCKWILLER, B.S. Agr.....Assistant in Animal Husbandry
CHARLES VINYARD WILSON, B.S. Agr.....Assistant in Animal Husbandry
ANDREW JACKSON DADISMAN, M.S. Agr.....Farm Economics
JAMES HARVEY SHAFFER. B.S. Agr.....Assistant in Farm Economics
FERRIS DEWEY CORNELL, B.S.....Assistant in Farm Machinery
CHARLES AUGUSTUS LUEDER, D.V.M.....Veterinary Science
CHARLES ELLSWORTH STOCKDALE, B.S. Agr.....Agricultural Editor
JOHN CHARLES JOHNSTON.....Chief Clerk

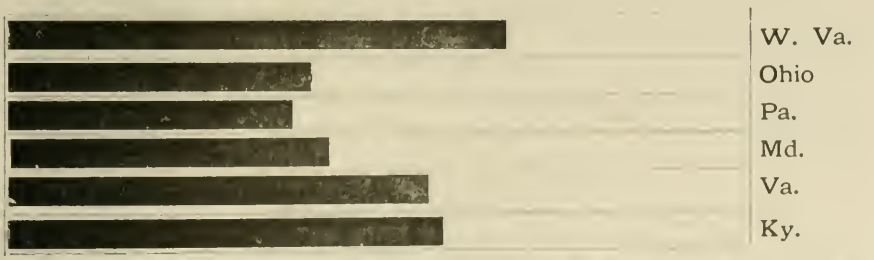
*In co-operation with the U. S. Department of Agriculture.

West Virg.. a Pastures

Owing largely to its rugged topography, West Virginia is probably better adapted to the production of livestock than to any other farming industry. The commercial livestock industry of the State is confined principally to the raising and grazing of cattle and sheep because grain is not produced in sufficient quantity to be used in fattening animals except in the Eastern Panhandle and in one or two minor areas along the Ohio River. At least 95 per cent of the cattle and sheep sent to market go directly from pastures instead of from the feed lot. This fact alone emphasizes the dependence of the livestock industry on pastures.

About 88 per cent of the area of the State is unimproved and pasture land, and the remaining 12 per cent is in crops. No doubt a part of the unimproved land furnishes considerable grazing for livestock and large areas of the more favorably situated cut-over timber land could be cleared and seeded to grass for permanent pasture. West Virginia has a greater percentage of its improved land in pasture than any of the bordering states. The diagram below compares the proportion of improved land in pasture in West Virginia with that of the five bordering states.

It is probable that the value of our pasture grass is larger than that of any other crop. The sales of livestock on the average farm of the State are the largest factor in determining the net farm income and the pastures on the farm regulate the amount that is derived from the livestock industry. Only with these facts in mind can we realize the importance of knowing how to get our pastures in prime condition and permanently maintain them.



Proportion of the Improved Land in Pasture in West Virginia as Compared to That of Bordering States.

*I. S. Cook, the author of this bulletin, was formerly a member of the Experiment Station staff as research agronomist.

A GOOD PASTURE

The question of what is a good pasture has been asked many times of farmers and others interested in this problem and, while no definite agreement seems to prevail, it can be stated that the general opinion seems to be that any pasture that will furnish abundant grass from 2½ acres for a 1,000-pound cow or steer during the grazing season may be called a good pasture.

During the summer of 1915 the Department of Agronomy made a pasture survey of some typical grazing counties of the State together with two counties which were considered among the poorer pasture counties. The object of this survey was to ascertain the exact condition of the pastures. Two hundred and forty-six farmers were visited in Gilmer, Harrison, Nicholas, Pendleton, Upshur, and Wayne counties and from them data were secured and recorded concerning the following subjects:

1.—The treatment of the land before and after becoming a pasture.

2.—The constitution of the pasture flora, both as to desirable plants and as to weeds and briers commonly known as "filth."

3.—The manner and time of grazing the pastures.

4.—The methods used to remove "filth" from the pastures.

5.—The land required to maintain livestock and the gains made by such livestock.

6.—The value of the land per acre.

7.—The methods farmers believe they can pursue and thus improve their pastures.

As stated before, the opinion of many farmers as to what constituted a good pasture seemed to be one which would require about 2½ acres to graze a 1,000-pound animal on hill pasture land. This area is 1 to 1½ acres less than is now required as shown in the following table.

The following table shows the number of acres required to graze an animal, the value of the land, the total gain, and the gain in live weight per acre as reported by 246 farmers in six counties of the State.

TABLE 1.—Summary of Dat Secured in Pasture Survey in Six West Virginia Counties

County	No. Reporting	Value of Land Per Acre*	Two-Year-Old Cattle		
			Acres Per Animal	Total Lbs. Gain	Lbs. Gain Per Acre
Gilmer	30	$35.54	3.0	286.3	95.4
Harrison	21	68.85	3.6	306.0	85.0
Nicholas	40	27.18	3.3	233.0	70.1
Pendleton	43	34.12	3.1	305.0	98.4
Upshur	42	53.92	4.1	331.2	80.8
Wayne	70	18.14	3.3	291.0	88.2
Average		39.63	3.4	292.1	86.4

County	Three-Year-Old Cattle			Cows
	Acres per Animal	Total Lbs. Gain	Lbs. Gain Per Acre	Acres Per Animal
Gilmer	3.8	329.1	86.6	3.4
Harrison	4.8	324.0	67.5	4.8
Nicholas	5.5	271.2	49.3	3.6
Pendleton	5.0	321.0	64.7	3.9
Upshur	4.6	368.0	80.0	4.5
Wayne	3.9	248.9	63.8	3.4
Average	4.6	310.4	68.6	3.9

*Value of pasture land as given by the owners in 1915.

The value of pasture land varies considerably in the different counties but in most counties the interest on the investment in land plus the taxes amounts to about 70 per cent of the value of the gain produced, thus leaving only a small margin which might be expended toward improving the grass. The cost of fencing was not considered in the foregoing figures. If some treatment of the grass land can be found that will bring about improvement and the cost not exceed the value of the improvement, then pastures should be made to carry more animals on a given area than are now being grazed.

CAUSES OF POOR PASTURES

There is a general agreement to the effect that the pastures are run down and not nearly so good as they were at an earlier period. Before presenting methods of improving pastures it is well to consider what have been the causes of pasture deterioration in this State. As to the causes of the run-down condition of pastures, there does not seem to be any general agreement among farmers. Of the 246 farmers interviewed, 98 per cent suggested reseeding, 56 per cent suggested liming, and only 9 per cent suggested applying a carrier of phosphorus.

It was found in the pasture survey that 68 per cent of the pasture land had been cropped previous to establishing as a permanent

pasture while a small per cent of the farmers broke up the pasture frequently and cropped. One reason why many pastures are thin, is the surface washing of the hill land which removes a large amount of the original store of humus accumulated during the years the land was covered with timber. Another cause of deterioration is too early spring grazing. In many cases cattle or sheep run on pasture most of the winter thus causing injury. Usually the stock is removed when snow covers the ground and no feed is obtainable by the animals.

Turning Stock to Pasture in Spring

The time of turning stock to pasture in spring is influenced by several things; namely, the beginning of spring work, the shortage

Turning Stock to Pasture Too Early in the Spring Doesn't Give the Grass a Chance to Get a Fair Start.

of feed, and the time when grass begins to grow. It was found that 54 percent of the farmers interviewed turned their stock to pasture before the first of May, that 80 per cent turned out before the fifth of May, and that a few kept their stock on pasture all the year. There is no doubt that the practice of turning stock to pasture early in the spring before the grass has had a chance to make a good growth has had most to do with the deterioration of pastures. It is seldom that grass has made a good growth in this State be-

fore the tenth or fifteenth of May. In other words, farmers in general begin harvesting their pasture crop long before it has made its growth.

The Forestry Division of the Department of Agriculture has carried on grazing tests in the West and the following brief summary of recent experiments has been furnished the author by Will C. Barnes, Assistant Forester. "In Utah, recent investigations have shown that where perennial forage plants are clipped three or four seasons in succession a few days after growth begins, or where leafage is removed three or four times in a season to correspond with certain grazing practices, the subsequent growth is weak and invariably the plants are in a low state of vigor. On the other hand, where stock is kept off the range for about two weeks or so after growth starts, a time when the flower stalks in most of the early maturing grasses begin to appear, a good growth of forage is produced, provided, of course, that the plants are not cropped too closely later during the growing season. The most common source of range abuse is due to too early grazing in the spring. Close cropping after seed maturity seldom if ever results in injury to the forage cover."

The different methods of grazing as described by James T. Jardine and by Arthur W. Samson, which have resulted in marked improvements of the range pastures wherever tried could well be followed in a modified way in this State. Both of these authors in their respective papers state that premature grazing and overstocking go together as the most direct causes of deterioration in western pastures. By dividing the area to be grazed into three separate ranges, keeping the stock off one of the ranges for one year and off a second one until flowering stalks of the majority of the different grasses have formed, and continuing to alternate the grazing on the three ranges in the above way for succeeding years, marked improvement in the grass will result.

The data collected and observations made in the pasture survey in this State very forcibly point out the reason why pastures have deteriorated. There is no hope of improving our pastures so long as farmers continue to turn their stock to pasture before grass has made a good growth in the spring and then continue to keep them on the same pastures until late in the winter and in too many cases all winter. It is a waste of money and time to apply seed and fertilizing materials on pastures unless opportunity for growth is

given in the spring as well as permitting some protection to the roots in winter by allowing the dead herbage to remain on the ground. Midsummer cutting of weeds in pastures should always be done wherever they are to be found, no matter what method of grazing is followed.

There are a few excellent examples of what intelligent pasturing will do in this State, and the number of animals that these pastures are able to carry from May fifteenth to October first has been doubled. **These pastures have been improved not by the applications of fertilizer but by giving the grass an opportunity to make a good growth so that the root system could be fully developed.**

Professor Horace Atwood, who took charge of the West Virginia Experiment Station farm in 1900, states that one acre of pasture now on the farm is equal to three acres of pasture at that time, and that this change has been brought about largely by clearing the pasture of various weeds, brushes, and briers and by intelligent pasturing of the land. In other words, stock was not turned on the pasture until after the grass had made a good growth in the spring and the animals were taken off after the silos were filled in the fall. In recent years it has required less than two acres to graze a dairy cow from May 20 to September 15, which may be considered good for a DeKalb soil.

Before any general pasture improvement can be made it is necessary that farmers should understand that plant growth takes place from conditions existing above as well as below the ground. It is necessary to have a large leaf area to produce rapid growth, and when some of the grass blades die and remain on the ground they afford considerable protection to the roots from the hot, dry sun of midsummer and furnish winter protection. If a manufacturing plant is to reach its highest efficiency in the production of a certain article it must be maintained on a plane that will permit the necessary work to be done, and if a farmer wishes to secure the greatest growth of grass it is necessary to have the top growth of the plants sufficiently large to enable them to manufacture plant substances like starch or cellulose rapidly enough to attain their maximum development. The organic matter of which the roots are largely composed is all manufactured in the leafy portion above ground. If this leafy portion is eaten off too frequently or too closely, root growth will be restricted and after a time the sod will become thin and patchy and weeds and filth will take the place of grass.

Heavy vs. Light Grazing

In recent years there has been considerable discussion of the effect of heavy and light grazing on pasture. Among the first to advocate heavy grazing was Carrier of the Virginia Experiment Station. His conclusions after three years of grazing with one or two steers on 2½-acre plots, supplemented by frequent mowing of small areas, indicated that heavy grazing improved blue grass pastures while light grazing did not.

The data gathered from the pasture survey of this State indicate that heavy grazing should be practiced during the mid-summer months only, and not during April, May, September, and October. Cattle prefer the better grasses and the weeds are eaten only after the grass is gone. Several pastures examined in different parts of the State where light grazing has been practiced showed an excellent pasture sod much superior to the average. The terms, heavy and light grazing, have, perhaps, a different meaning to different persons. If the term "heavy grazing" means the keeping down of all grasses in a pasture from the beginning of growth in the spring until the end of growth in the fall, as is done in too many instances, then deterioration of the pasture is inevitable. If heavy grazing is practiced during midsummer after a good growth of grass has taken place perhaps little injury will result.

IMPROVING PASTURES

In recommending any method for improving pastures it is of first importance to recognize their practical application on the farm. Any treatment that makes the total cost per acre (including taxes, fences, interest, etc.) equal to the value of 70 pounds live weight of good three-year-old beef cattle in this State must be regarded as an investment that can be expected to return only a small interest. On field crops the total cost of an application of lime, acid phosphate, and seed generally brings about a sufficient increase in yield to return the total cost of the treatment and a margin besides after one or two crops are harvested in the rotation, but this has not been the case in treating old pastures.

From the pasture survey work it was shown that only 70 pounds of beef are produced per acre on the average for the whole grazing season by pasturing three-year-old steers. At the present (1920) price of beef this means that an acre of average pasture in this State

is returning only a value of $8.00 to $10.00 per acre figuring beef cattle off grass worth 12 to 14 cents per pound. If the interest upon the investment of the land is deducted from this amount, together with taxes and fence charges, it leaves a net return of approximately half that amount. Four to five dollars' worth of seed, fertilizer, and lime will not go very far at present prices toward improving an acre of pasture land. If this amount per acre is expended one can not expect a 25 to 50 percent improvement in the pasture which would be necessary to equal the effect of these materials when applied to cultivated land.

There are perhaps many instances where farmers are justified in making an expenditure of $4.00 to $5.00 per acre on their pastures, if they have sufficient operating capital, but a vast number of farmers do not care to make such an indefinite investment. Under West Virginia conditions it is very questionable whether anyone should recommend the expenditure of money in fertility treatments on pastures until farmers have first drained, limed, and fertilized all their cultivated land to insure profitable returns. The one definite decisive method which farmers can pursue in improving their pastures is to remove the principal cause of poor pastures; namely, **overgrazing. So long as farmers continue to turn their stock to pasture before the grass has made a good growth in the spring and keep them on until snow prevents them from getting anything to eat, no improvement of pastures can be made that** will **have a lasting effect.**

In order for farmers to permit the grass to get a good start before turning out their stock it will in most cases be necessary to provide a silo which will enable them to store the necessary amount of feed to carry their stock up to that time. Where one has two pastures, one of which is small, being only sufficient to graze the stock on the farm for three or four weeks, this small pasture could be allowed to produce a growth of grass during July and August and the fall months, and could be grazed off the following spring. This small pasture will supplement the silage or hay that is fed to cattle in April and May and insure the necessary amount of feed to hold the cattle off the main pasture until late in the spring. If this method is followed, combined with the practice of cutting brush and briers early in June and the clipping of weeds in midsummer, improvement will result.

The sowing of clover and grass seed on portions of the pasture, where the sod is broken and thin, together with an application of acid phosphate will effect improvement, provided stock is kept off the areas treated long enough to enable the clover and grass to get a start. For the most rapid improvement with the least expenditure of money the above recommendations must be combined and persistently followed.

Where farmers are fortunate enough to get tobacco stems, or other mulching material free from weeds, or manure, marked improvement of the pasture will take place wherever these materials are applied.

No definite recommendations can be made in regard to lime. Our present knowledge on this question seems to indicate that the application of lime alone, in the majority of cases, has little effect on bringing in the clover plants, but when acid phosphate is added, the effect is beneficial in improving the pasture in many cases.

There is one striking exception to the above statement. On P. S. Lewis's farm near Point Pleasant an application of lime alone on old blue grass sod produced such a thick growth of white clover that the division line between the limed and unlimed part of the sod was very distinct when viewed at a distance of over 100 yards from the pasture field. There are so many other cases where no effect was noticeable by the application of lime alone on pastures that it is recommended that farmers lime only a small area of pasture land and note the effect for two years before any great expenditure of money is made by applying lime alone to large areas.

Although acid phosphate or bone meal may, in certain instances, prove profitable in bringing in the clover, yet much better results will generally be secured by sowing some clover seed wherever phosphorus is applied. Wherever a permanent pasture is being established by plowing and fitting the soil, then lime should be applied in all cases along with a carrier of phosphorus and a liberal sowing made of clover and grass seed. When lime is applied in this way it has an opportunity to become thoroughly mixed in the surface soil and produce favorable conditions for the growth of clover.

The experiments of Frank H. Ballou of Ohio on orchard fertilization on soils somewhat similar to those of this State, showed that acid phosphate or ground bone liberally applied each season to land that had been in orchards for a number of years produced a vigor-

ous growth of white or red clover or both without seeding. Where nitrogen alone was applied it produced a vigorous growth of different kinds of grasses to the exclusion of clover.

The application of nitrate of soda and acid phosphate produced a growth of grasses and clover but where nitrate of soda is used in too heavy applications the grasses are likely to develop so much more promptly or rapidly, that the clovers are, by crowding, more or less completely eliminated from the partnership.

The application of fertilizer to a pasture may be expensive. Especially is this true of nitrogen, and if it is possible to get clover to grow where the blue grass in the pasture has disappeared, by sowing clover and grass seed and applying acid phosphate, it will be possible to get a cheaper source of nitrogen which will eventually bring in the pasture grasses.

Cutting Brush and Briers

One of the largest items of expense in the improvement of pasture is the eradication of briers, sprouts, weeds, etc. which are commonly called filth by farmers throughout the State. There has always been considerable discussion among farmers as to the best time to clean up a pasture. Since we know that the leaf is the organ in which a very large part of the plant substance is manufactured, it is necessary to cut before the leaves have functioned sufficiently long to have stored up a supply of material. **The cleanest pastures were found where the filth had been cut during the first half of June or soon after the leaves had reached full development. This is the proper time for cutting.** If, after the first cutting, sprouts are found growing in late summer they should again be cut the same season and the next year very little work will be required to eradicate the filth.

It is of interest to know the kinds of grasses commonly found in the pastures of the State.. The following table shows the kind of grasses found in 245 pastures of the State together with the different clovers that were present.

West Virginia Has Thousands of Acres of Cut Over Woodland Capable of Producing Fine Pasture Grass.

TABLE II.—Grasses and Clovers Found in the Pastures of Six West Virginia Counties

Grass or Clover	Gilmer 30 Farms	Harrison 21 Farms	Nicholas 40 Farms
Kentucky Blue Grass	30	21	21
Orchard Grass	11	10	20
Timothy	5	7	27
Broomsedge	17	2	26
Red Top	4	7	34
Poverty Grass (Danthonia)	9	14	4
Meadow Fescue	3	....	6
Canada Blue Grass	....	....	1
Velvet Grass	....	....	8
Soft Chess	....	....	....
Tall Meadow Oat Grass	....	....	....
Indian Grass	....	....	....
White Clover	24	18	19
Red Clover	5	7	18
Japanese Clover	20	....	10
Alsike Clover	1	1	1
Low Hop Clover	....	....	....

Grass or Clover	Pendleton 43 Farms	Upshur 42 Farms	Wayne 69 Farms	Totals 245 Farms
Kentucky Blue Grass	43	31	63	209
Orchard Grass	4	14	37	96
Timothy	13	20	24	96
Broomsedge	4	26	10	85
Red Top	4	12	21	82
Poverty Grass (Danthonia)	20	32	3	82
Meadow Fescue	...	1	1	11
Canada Blue Grass	4	1	3	9
Velvet Grass	....	....	....	8
Soft Chess	....	2	4	6
Tall Meadow Oat Grass	....	2	....	2
Indian Grass	....	1	....	1
White Clover	38	28	35	162
Red Clover	3	20	26	79
Japanese Clover	....	1	17	48
Alsike Clover	2	2	....	7
Low Hop Clover	1	2	....	3

Kentucky blue grass (Poa pratensis) is the predominant pasture grass and white clover (Trifolium repens) is the predominant clover. It was quite noticeable that the clover was too thinly scattered over the pastures to rapidly replenish the nitrogen supply in the soil. The lack of available phosphorus has very largely been the cause of the small growth of clover.

Clover and Grass Seed Mixtures

The proportions of the different clovers and grasses in seed mixtures are immaterial so long as dependable pasture grasses and clovers occupy a prominent part of the mixture. In this State, Kentucky blue grass and white clover are the two outstanding pasture plants of the grass and legume families that hold best in permanent pastures. Timothy, red top, orchard grass, and red and alsike clover are the plants that make a rapid growth the first two years and which are later replaced to a large extent by blue grass. Red top is not very palatable and to a less extent the same may be said of orchard grass. Therefore, the amount of seed of these two added to the mixture should be small. A seed mixture containing 10 pounds of Kentucky blue grass, 4 pounds of timothy, 2 pounds of red top, 2 pounds of orchard grass, 2 pounds of red clover, 2 pounds of alsike, and 1 pound of white clover will prove quite satisfactory. Where meadow fox tail can be had, 4 pounds of it added to the mixture may be recommended. There are many instances where some of the above seeds may as well be left out of the mixture and the principal ones increased in amount. Twelve

pounds of blue grass, 5 pounds of timothy, pounds of white clover, and 3 pounds of Japanese clover make a ry satisfactory mixture.

An experiment begun at Cornell Station in 1903, seeding plots to different mixtures of grasses, showed Kentucky blue grass and meadow fox tail to be the most permanent grasses on the plots in 1910, with Kentucky blue grass leading.

PASTURE RENOVATION EXPERIMENT

In the spring of 1913 an experiment was begun on a small area of a pasture field on the W. Va. Experiment Station farm with the idea of measuring the effect of different treatments on pasture land by grazing sheep. Four acres of hill pasture were fenced off from the main pasture and this area divided into four one-acre lots to be given different treatments. The production of grass was to be measured by the number and weight of the sheep that could be maintained on each lot without their losing weight.

The lots were so laid out as to permit nearly all the surface drainage to pass off lengthwise of the lots and, further to guard against any effect from the surface wash of fertilizing materials, the lowest lying lot was used for the fertilizer treatment and was designated as Lot 1.

The lots received the following treatment in April, 1913:

Lot 1:

Lime, largely air-slaked from one ton caustic lime.
500 pounds of fertilizer composed of 125 pounds of high grade blood, 68 pounds nitrate of soda, 150 pounds steamed bone meal, 87 pounds of 16 percent acid phosphate, and 70 pounds of muriate of potash, making a fertilizer analyzing 6 percent nitrogen, 10 percent phosphoric acid, and 7 percent potash.
A mixture of 10 pounds red clover, 12 pounds timothy, and 4 pounds red top.

All of these materials were applied broadcast in April and harrowed in with a spike tooth harrow run over the lot once.

Lot 2:

A similar application of lime and grass seed as on Lots 1 and 2 was harrowed in, but the fertilizer was omitted.

Lot 3:

A similar application of lime as on Lots 1 and 2 but fertilizer and grass seed were omitted. Same harrowing given this lot as 1 and 2.

Lot 4:

No treatment.

All of the lots had been in permanent blue grass pasture for more than twenty-five years. Lot 1 was considered much the poorest of the four with a gradual improvement from Lot 2 to 4.

The division fences were not put up in time to keep the lots separate during the summer of 1913, and dairy cattle had free access to all lots until the first of September when the fences were built and the dairy cows kept out during the fall.

On May 8, 1914, without further treatment, matured ewes that were not bred the previous fall were turned on the lots. Four ewes were turned in each lot. On May 21 they were taken off, weighed, sheared, and returned to the lots on May 22 after weighing again. On July 31 the sheep were changed and two more added to each lot making six in each lot until September 15 at which time all the sheep were taken off.

TABLE III.—Results of Pasture Grazing by Sheep (1914)

Lot	Date Turned On	Kind of Animals*	Total Initial Wt.	Date Taken Off	Total Final Wt.	Gain	Ave. Live Wt. Maintained	Total Gain For Summer	Ave. Weight Maintained for Summer	Days of Pasture
1	5-8	1 Southdown, 3 Delaines	315	5-21	352	37	333.5			
1	5-22	Weight after Shearing	285	7-31	323	38	304.0			
1	7-31	6 Rambouillets	540	9-15	441	−99	490.5	−24	372.9	130
2	5-8	1 Southd., 2 Del., 1 Rambouillet	302	5-21	352	50	327.0			
2	5-22	Weight after Shearing	287	7-31	335	48	311.0			
2	7-31	6 Delaines	445	9-15	413	−32	429.0	66	354.4	130
3	5-8	1 Southdown, 3 Delaines	306	5-21	345	39	325.5			
3	5-22	Weight after Shearing	289	7-31	339	50	314.0			
3	7-31	6 Delaines	408	9-15	458	50	433.0	139	357.3	130
4	5-8	1 Southdown, 3 Delaines	332	5-21	410	78	371.0			
4	5-22	Weight after Shearing	322	7-31	386	64	354.0			
4	7-31	6 Delaines	413	9-15	525	112	469.0	254	396.4	130

*All mature ewes unless otherwise designated.

It will be noted in Table III that the sheep were on the pasture 130 days and that during this time Lot 4 maintained more live weight of sheep and made a greater gain than any of the other lots. The sheep on the lots for this year emphasized the difference that existed between the grass on lots before the effects of the fertilizer developed. While, as stated above, this land had been in permanent

blue grass for many years, the cinquefoil (Potentilla canadensis, L.) on Lot 1 had replaced most of the blue grass on portions of the lot thus requiring more than one year for it to make much of a showing. Cinquefoil also existed over portions of Lot 2 but to a less extent than on Lot 1. While Lots 3 and 4 had a fairly uniform blue grass sod, the grass on Lot 3 was not so good as that on Lot 4.

In May, 1915, thirty Delaine Merino wethers one year old were purchased and turned on the pasture lots May 15, seven to a lot, with two held in reserve. The weight of each sheep was recorded separately and weights were taken regularly every two weeks. After the first month on pasture if the sheep on a lot were found to be losing in weight, one was taken off, or if too rapid gains were being made on any lot, one of the sheep held in reserve was turned in, so that the full maintenance of each lot was determined every two weeks. The sheep held in reserve were kept in the main pasture field of the Experiment Station Farm and are indicated in the following table under Lot 0.

Table IV shows the behavior of each sheep and when a sheep was removed from each lot. The date of turning the sheep on the lots is a little over two weeks later than the average date farmers of the State turn out. The grass in all lots had made a good growth and the sheep made rapid gains the first month on pasture. All sheep that did not make more than 6½ pounds gain for the month were taken off and held in reserve.

Table IV which follows summarizes the season's results on the four lots.

TABLE IV.—Individual Weights of Sheep on Pasture (1915)

Sheep Number	Lot Number	Weight 5-15	Gain or Loss									Total Gain	Final Weight Oct. 12
			6–16	7–3	7–17	7–31	8–14	8–31	9–11	9–25	10–12		
13	1	78.5	9.5	−5.0	−1.0	−0.5	6.5	−5.5					
	0								10.5	−3.0	−6.0	5.5	84.0
14	1	73.5	11.0	−4.0	−1.0	−2.0	4.5	4.5	−1.0	2.0	−3.5	7.0	80.5
15	1	66.5	8.0	−2.5	−1.0								
	0					0.5	3.5	1.0	0.0	8.0	11.0	6.5	73.0
16	1	68.5	9.0	−4.5	1.5	3.5	−2.0						
	0							5.0	2.0	−1.0	−0.5	13.0	81.5
17	1	69.0	9.5	−2.5	2.0	2.0	0.0	−0.5	0.5	−1.0	−3.5	6.5	75.5
18	1	62.5	11.0	−2.5	3.0	−0.5	0.5	−3.0	−6.0	6.0	−3.0	5.5	68.0
19	1	71.5	12.0	−3.5	−1.0	0.5	3.5	−1.0	3.0	−4.5	−1.5	7.5	79.0

Sheep Number	Lot Number	Weight 5-15	Gain or Loss								Total Gain	Final Weight Oct. 12
			6–16	7–3	7–17	7 31	8–14	8–31	9–11	9–25	10–12		
20	2	77.5	6.0									
	0			0.0	5.0	−4.0	5.5	1.0	−6.5	11.5	−3.0	15.5	93.0
21	2	65.5	8.0	−8.0	1.5	4.0	2.5	−1.0	0.5	0.0	−2.0	5.0	70.5
22	2	68.0	7.5	−2.5	0.5	4.0	−1.5	1.0	−1.0	3.0	−2.5	8.5	76.5
23	2	68.0	8.0	−8.0	1.0	1.0	−2.0						
	0							3.0	7.0	−1.0	−3.0	6.0	74.0
24	2	76.5	11.5	−10.0									
	0				9.0	−1.5	5.5	3.0	−9.0	11.5	−2.0	18.0	94.5
25	2	59.0	5.5										
	0			5.5	4.0	−1.5	0.5	5.0	−1.0	5.5	−2.5	21.0	80.0
26	2	67.5	10.5	−2.5	0.5	−1.0	0.0	1.0	−0.5	0.0	−2.5	5.5	73.0
30	3	77.0	8.0	−3.0	2.0	0.0	1.0	1.0	4.0	−2.0	−3.0	8.0	85.0
31	3	73.0	8.5	11.5									
	0				10.0	−5.0	3.0	5.0	1.0	3.5	−3.5	11.0	84.0
32	3	68.5	8.5	−5.0	−2.5	5.5	0.0	4.0	2.0	−4.0	0.0	8.5	77.0
33	3	78.5	9.5	−5.5	1.0	4.0	3.5	0.0	3.0	−2.0	−3.0	20.5	99.0
34	3	68.5	6.5										
	0			4.5	0.5	−4.0	4.0	0.0	0.0	8.0	−3.0	16.5	85.0
35	3	62.5	12.5	−3.5	−0.5	−0.5	0.0						
	0							6.5	1.0	3.0	−1.5	17.0	79.5
36	3	68.5	8.0	−8.0	0.0								
	0					2.5	4.0	4.0	−6.0	10.0	−6.0	8.5	77.0
40	4	75.0	10.5	−2.5	2.5	−1.0	0.0	1.5	−2.0	3.5	−2.5	10.0	85.0
41	4	82.0	8.5	−0.5	2.5	−2.0	1.0	−0.5	9.0	−4.5	−3.5	10.0	92.0
42	4	61.5	9.5	−4.0	1.0	0.0	1.0	1.0	−3.0	−0.5	−1.5	3.5	65.0
43	4	75.0	11.0	−1.0	−5.0								
	0					−2.0	2.0	5.0	6.0	1.0	−4.0	13.0	88.0
44	4	62.5	11.0	−2.5	3.0	1.0	−0.5	3.5	−5.0	1.0	−3.0	8.5	71.0
45	4	64.0	11.0	−3.0	1.0	0.0	−2.0						
	0							5.0	0.0	0.0	−3.0	9.0	73.0
46	4	68.5	10.5	−1.0	−3.0	1.0	−2.0						
	0							10.0	0.5	3.5	−3.0	16.5	85.0
50	0	70.0	12.0			−0.5	3.0	4.0	−4.0	5.0	−3.5	11.5	81.5
	2			0.5	−4.0								
51	0	59.5	10.5	3.0	7.5	−2.5	2.0	2.0	2.5	3.5	−4.0	24.5	84.0

The sheep were on the lots 150 days as noted in Table V and during that time Lot 1 maintained 447.2 pounds, live weight sheep on the average throughout the season and produced a gain of 42.5 pounds, which indicates that the treatment given it in 1913 was showing its effect and had brought it up to Lot 4 in growth of grass. The reason for this advancement could readily be seen by the appearance of the lot. Clover was abundant on this lot and it was not necessary to remove any sheep from this lot until July 31, or until the clover had ripened, while on Lots 2 and 3 it was necessary to take out sheep previous to this time.

The first clover to make its appearance was low hop clover which began to come naturally as a result of the fertilizer on Lot 1 during the summer of 1914. It was more prominent in 1915. The red clover did not show up until the summer of 1915 when it was

TABLE V.—Summary of Season's Results of Sheep on Pasture (1915)

Plot	No. of Sheep	Date Turned On	Date Taken Off	Days in Period	Initial Weight	Final Weight	Gain or Loss	Average Live Weight Maintained	Total Gain for Summer	Average Wt. Maintained for Summer	Days of Pasture
1	7	5-15	6-16	32	489.5	559.5	70.0	524.5			
1	7	6-16	7-3	17	559.5	535.0	−24.5	547.3			
1	7	7-3	7-17	14	545.0	549.5	4.5	547.2			
1	6	7-17	7-31	14	468.5	475.5	7.0	472.0			
1	6	7-31	8-14	14	475.5	488.5	13.0	482.0			
1	5	8-14	8-31	17	412.5	398.0	−14.5	405.3			
1	4	8-31	9-11	11	315.5	312.0	−3.5	313.7			
1	4	9-11	9-25	14	312.0	314.5	2.5	313.3			
1	4	9-25	10-12	17	314.5	303.0	−11.5	308.7	43.0	447.3	150
2	7	5-15	6-16	32	482.0	539.0	57.0	510.5			
2	6	6-16	7-3	17	473.0	442.0	−31.0	457.5			
2	5	7-3	7-17	14	364.0	363.5	0.5	363.8			
2	4	7-14	7-31	14	285.0	293.0	8.0	289.0			
2	4	7-31	8-14	14	293.0	292.0	−1.0	292.5			
2	3	8-14	8-31	17	224.0	225.0	1.0	224.5			
2	3	8-31	9-11	11	225.0	224.0	−1.0	224.5			
2	3	9-11	9-25	14	224.0	227.0	3.0	225.5			
2	3	9-25	10-12	17	227.0	220.0	−7.0	223.5	29.5	337.3	150
3	7	5-15	6-16	32	496.5	558.0	61.5	527.3			
3	6	6-16	7-3	17	483.0	446.5	−36.5	464.8			
3	5	7-3	7-17	14	376.5	376.5	0.0	376.5			
3	4	7-17	7-31	14	308.0	317.0	9.0	312.5			
3	4	7-31	8-14	14	317.0	321.5	4.5	319.3			
3	3	8-14	8-31	17	251.0	256.0	5.0	253.5			
3	3	8-31	9-11	11	256.0	265.0	9.0	260.5			
3	3	9-11	9-25	14	265.0	257.0	−8.0	261.0			
3	3	9-25	10-12	17	257.0	251.0	−6.0	254.0	38.5	360.3	150
4	7	5-15	6-16	32	488.5	560.5	72.0	524.5			
4	7	6-16	7-3	17	560.5	546.0	−14.5	553.3			
4	7	7-3	7-17	14	546.0	548.0	2.0	547.0			
4	6	7-17	7-31	14	468.0	467.0	−1.0	467.5			
4	6	7-31	8-14	14	467.0	464.5	−25.5	465.8			
4	4	8-14	8-31	17	319.5	325.0	5.5	322.3			
4	4	8-31	9-11	11	325.0	324.0	−1.0	324.5			
4	4	9-11	9-25	14	324.0	323.5	−0.5	323.8			
4	4	9-25	10-12	17	323.5	313.0	−10.5	318.3	49.5	439.4	150

quite prominent. From this time on the clover had a marked effect on Lot 1 as will be seen in the grazing test of 1916. The fertilizer sown on Lot 1 apparently had more of a direct effect in producing a good growth of clover and only a minor effect in causing a greater growth of blue grass where it formed sufficient sod to make itself noticeable. Where only seed and lime were applied on Lot 2 no effect has thus far been indicated and no clover had made its appear-

ance. Apparently some fertilizing material was lacking and so it was decided that phosphorus was the fertilizing material needed to start the clover and on March 11, 1916, Lot No. 2 received an application of six pounds of red clover, five pounds of alsike and one pound of white clover. Two weeks later three hundred pounds of 16 percent acid phosphate were scattered over the lot. No further treatment was given to any of the other lots. It was very noticeable during the summer that low hop clover was very abundant on Lots 1 and 2. Alsike clover and white clover were also in evidence on the two lots.

During the summer and autumn of 1916 yearling grade Dorset-Merino wethers were grazed on the pasture lots and the sheep weighed bi-weekly, approximately, as during the previous year. Table VI shows the behavior of each sheep and also when a sheep was removed from each lot.

TABLE VI.—Results of Grazing Yearling Wethers (1916)

Sheep Number	Lot Number	Weight May 31	Gain or Loss									Total Gain	Total Weight Oct. 13
			6–17	7–1	7–18	7–31	8–12	8–26	9–9	9–26	10–13		
27	1	84	10	1	2	−4	0	1	−4	−1	5	6	90
29	1	65	9	0	−2	0	7	−3	4	−1	−2	12	77
37	1	72	10	0	−1	−6	−2	1	6	2	7	17	89
38	1	66	9	−1	−2	−3					8	11	77
39	1	80	15	0	−4	−5	2	−1	−2	2	−6	1	81
48	1	70	11	1	1	2	2	0	0	2	2	24	94
52	2	87	13	2	−3	−2	1	0	−4	3	3	13	100
53	2	72	11	1	−4	−3	2	4	1	4	0	16	88
54	2	70	10	3	−7	−2	4	−2	−2	−2	5	7	77
55	2	73	12	−2	−2	−2	1	0	2	2	0	11	84
56	2	74	7	−1	−5	−2					13	12	86
57	2	64	8	0	−3	−2	3	4	6	−2	1	15	79
60	3	77	10	1	−3	−3	4	−1	−2	1	4	11	88
61	3	84	11	0	−3	−3	−3	−1	1	4	0	6	90
62	3	68	11	1	−2	−2	−2	0	2	0	−3	9	77
63	3	71	10	2	0	0	3	0	−2	2	1	16	87
64	3	78	8	1	−5	−2					14	16	94
68	3	62	4	4	−1	1	0	4	−2	−2	0	8	70
70	4	86	8	2	−3	−6	−3	0	1	3	3	5	91
71	4	62	9	1	−4	−5				12	12	13	75
72	4	77	14	2	−3	−8	8	−6	0	2	1	10	87
73	4	78	9	0	−3	1	−3	0	7	1	0	12	90
74	4	64	9	0	−1	−2	2	0	4	0	3	15	79
75	4	71	8	1	−1	−3	4	2	2	−1	0	12	83

The sheep were on the lots 135 days and Lot 1 which was much the poorest pasture in the beginning had, by the effect of fertilizer on growth of clover, produced a greater total gain and maintained more weight of sheep than any of the other lots. Lot 2 which was next to the poorest at the beginning had equalled Lot 4 which contained the best sod of blue grass at the beginning of the experiment. The effect of the acid phosphate sown in the spring of 1916 on Lot 2 could be easily seen by the growth of low hop, alsike, and white clover on this lot which accounts for the advancement of this lot to second place as measured by the weight of sheep maintained and gain produced.

Table VII which follows summarizes the work for 1916.

TABLE VII.—Summary of Results of Sheep on Pasture (1916)

Lot	No. of Sheep	Date Turned On	Date Taken Off	Days in Period	Initial Weight	Final Weight	Gain or Loss	Average Live Wt. Maintained	Total Gain for Summer	Average Weight Maintained for Summer	Days Pastured
1	6	5-31	6-17	17	437.0	501.0	64.0	469.0			
1	6	6-17	7-1	14	501.0	502.0	1.0	501.5			
1	6	7-1	7-18	17	502.0	492.0	−10.0	497.0			
1	6	7-18	7-31	13	492.0	476.0	−16.0	484.0			
1	5	7-31	8-12	12	407.0	419.0	12.0	413.0			
1	5	8-12	8-26	14	419.0	417.0	−2.0	418.0			
1	5	8-26	9-9	14	417.0	421.0	4.0	419.0			
1	5	9-9	9-26	17	421.0	425.0	4.0	423.0			
1	5	9-26	10-13	17	425.0	431.0	6.0	428.0	63.0	450.9	135
2	6	5-31	6-17	17	440.0	501.0	61.0	470.5			
2	6	6-17	7-1	14	501.0	504.0	3.0	502.5			
2	6	7-1	7-18	17	504.0	480.0	−24.0	492.0			
2	6	7-18	7-31	13	480.0	467.0	−13.0	473.5			
2	5	7-31	8-12	12	394.0	405.0	11.0	399.5			
2	5	8-12	8-26	14	405.0	411.0	6.0	408.0			
2	5	8-26	9-9	14	411.0	414.0	3.0	412.5			
2	5	9-9	9-26	17	414.0	419.0	5.0	416.5			
2	5	9-26	10-13	17	419.0	428.0	9.0	423.5	61.0	445.3	135
3	6	5-31	6-17	17	440.0	494.0	54.0	467.0			
3	6	6-17	7-1	14	494.0	503.0	9.0	498.5			
3	6	7-1	7-18	17	503.0	489.0	−14.0	496.0			
3	6	7-18	7-31	13	489.0	480.0	−9.0	484.5			
3	5	7-31	8-12	12	400.0	406.0	6.0	403.0			
3	5	8-12	8-26	14	406.0	408.0	2.0	407.0			
3	5	8-26	9-9	14	408.0	405.0	−3.0	406.5			
3	5	9-9	9-26	17	405.0	410.0	5.0	407.5			
3	5	9-26	10-13	17	410.0	412.0	2.0	411.0	52.0	442.9	135

Lot	No. of Sheep	Date Turned On	Date Taken Off	Days in Period	Initial Weight	Final Weight	Gain or Loss	Average Live Wt. Maintained	Total Gain for Summer	Average Weight Maintained for Summer	Days Pastured
4	6	5-31	6-17	17	438.0	495.0	57.0	466.5			
4	6	6-17	7-1	14	495.0	501.0	6.0	498.0			
4	6	7-1	7-18	17	501.0	486.0	−15.0	493.5			
4	6	7-18	7-31	13	486.0	463.0	−23.0	474.5			
4	5	7-31	8-12	12	400.0	408.0	8.0	404.0			
4	5	8-12	8-26	14	408.0	404.0	−4.0	406.0			
4	5	8-26	9-9	14	404.0	418.0	14.0	411.0			
4	5	9-9	9-26	17	418.0	423.0	5.0	420.5			
4	5	9-26	10-13	17	423.0	430.0	7.0	426.5	55.0	445.5	135

After 1916 the grazing test was discontinued owing to a change in the Experiment Station staff. Flora examinations were made during the summers of 1917 and 1918. For complete data on the effect of the fertilizer on Lots 1 and 2 it would have been well to have continued this grazing of these lots two more years as at the end of 1916 Lots 1 and 2 were showing effects of the treatment given, and would likely have continued to do so for the following two years. The clover on Lot 2, especially the red, was more prominent in 1917 than in 1916 and both Lots 1 and 2 had considerable clover in them in 1918.

It required considerable time to make bi-monthly weighings but this is necessary so that a check may be had upon the periodical gain and loss of an individual sheep. A system of rotation of the sheep from lot to lot every two weeks would doubtless help to eliminate the error due to individual characters of the sheep and tend to give better data on the carrying capacity of the lot in question.

The test shows that a liberal application of nitrogen, phosphorus, and potassium together with a clover and grass seed mixture and lime will produce a good growth of grass even though the returns are not commensurate with the cost of the treatment. It was shown that an application of lime alone or lime and grass seed did not effect any improvement that could be measured. It was clearly shown that an application of acid phosphate along with a seeding of clover resulted in a good growth of clover scattered through the blue grass and increased the grazing capacity of the lot. In many instances it may prove profitable to apply 200 pounds of acid phosphate together with a clover and grass seed mixture.

Regardless of any fertilizer and seed treatment, the fact remains that pastures cannot be permanently maintained in a good condition unless they are intelligently grazed as emphasized in the preceding pages of this bulletin.

SUMMARY

1.—Approximately two-thirds of the improved area of West Virginia is in pasture.

2.—A survey of six counties in the State showed that it required approximately 4 acres of pasture to graze a cow, and a little more for a three-year-old steer.

3.—Over 80 percent of the stock on farms investigated was turned to pasture before the fifth of May and, in many cases, stock remained on pasture all winter or until removed because of lack of feed.

4.—The average acre of pasture, valued at $34.00 an acre, furnished sufficient feed to produce 70 pounds of gain on a three-year-old steer.

5.—To effect a permanent improvement of pastures it will be necessary for farmers to follow the practice of keeping the stock off the pastures until after the grass has made a good growth in the spring, usually about the tenth to the fifteenth of May.

6.—When the practice of turning stock on pasture late in the spring is followed, an application of clover and grass seed with acid phosphate may be given profitably to bare and broken sod portions of the pasture. Lime, in addition to these, may produce further improvement in some instances, although most tests where it has been applied to permanent pastures have given negative results, especially when applied without fertilizing materials.

7.—The grazing of yearling wethers on pasture lots receiving different treatments proved a satisfactory means of measuring the effect of the treatment.

8.—Harrowing and liming blue grass pasture did not bring about any improvement. Harrowing, sowing clover and grass seed, and liming gave negative results.

9.—An application of complete fertilizer along with the three other treatments mentioned above produced sufficient growth of clover to effect a marked improvement.

10.—An application of clover and grass seed with acid phosphate gave equally as satisfactory results as the complete fertilizer on a thin pasture sod with much less cost. Both of these lots had received applications of lime.